

RECLAMATION

Managing Water in the West

Active Adaptive Management on the Colorado River: The Glen Canyon Dam Experience

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Bureau of Reclamation

Tucson & Marana HCP Meetings
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Differing Views of Nature

- Biocentric/Arcadian

- Nature is benign
- Earth's resources limited
- Ecosystems delicately balanced
- Humans a part of nature
- We must respect and protect nature
- Environmental problems only solved by holistic approaches

- Anthropocentric/Imperial

- Nature hostile and neutral
- Natural world contains ample reserves
- Environment is resilient
- Humans separate from nature
- Nature here for human use
- Environmental problems can be solved by analytic/scientific reasoning

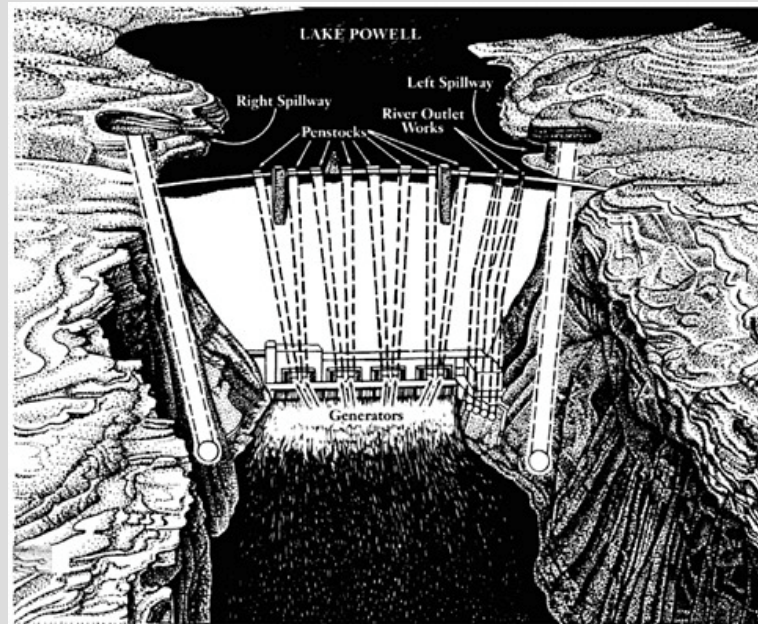
In 1956

- Dwight Eisenhower re-elected President
- Congress approves Highway Act, funding interstate highway system
- Fidel Castro begins revolution in Cuba
- Dr. Albert Sabin develops oral polio vaccine
- Rock and roll becomes a national phenomenon, fueled by the popularity of Elvis Presley
- Colorado River Storage Project Act passed

Colorado River Storage Project Act 1956

- Authorized Glen Canyon, Navajo, Flaming Gorge, and Aspinall Unit dams and participating projects
- To initiate comprehensive development of water resources of Upper Colorado River Basin:
 - Regulate flow of Colorado River
 - Store water for beneficial consumptive use to facilitate meeting Colorado River Compact apportionments
 - Provide for reclamation of arid and semiarid land
 - Control floods
 - Generate hydropower as an incident of the foregoing purposes, created Colorado River Basin Fund

In the District of Columbia, in the labyrinthine fastnesses of the Department of the Interior, somewhere above Sport Fisheries and Wildlife and beyond the Office of Saline Water, there is a complex of corridors lined with murals of enormous dams. This is Reclamation, and these are its monuments...

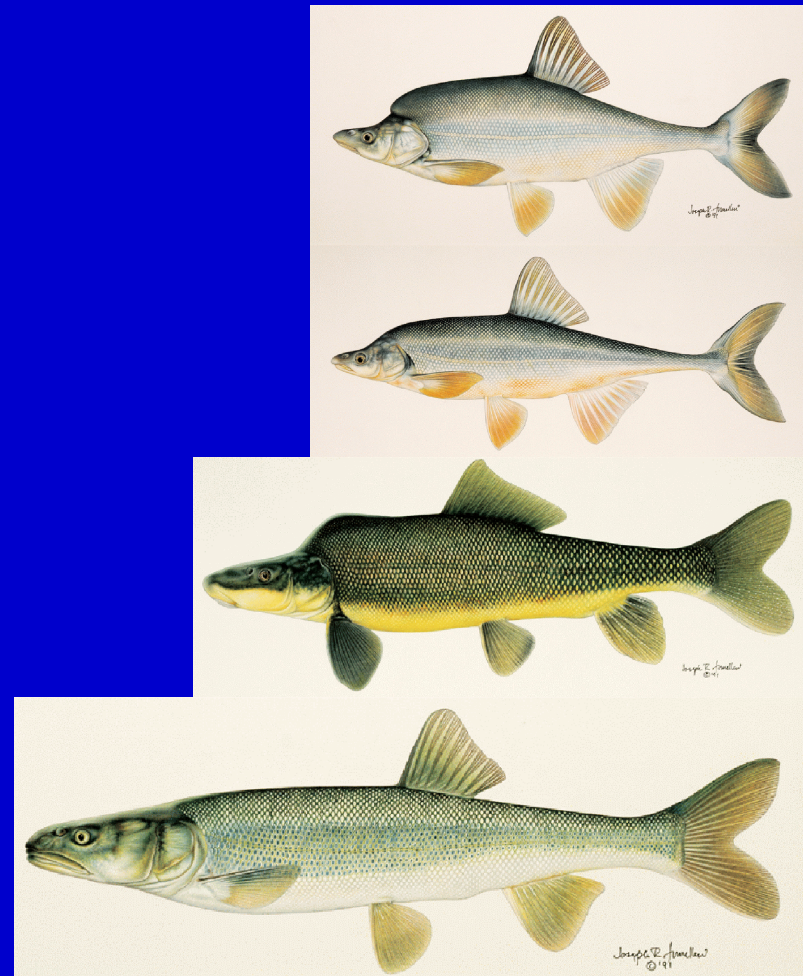
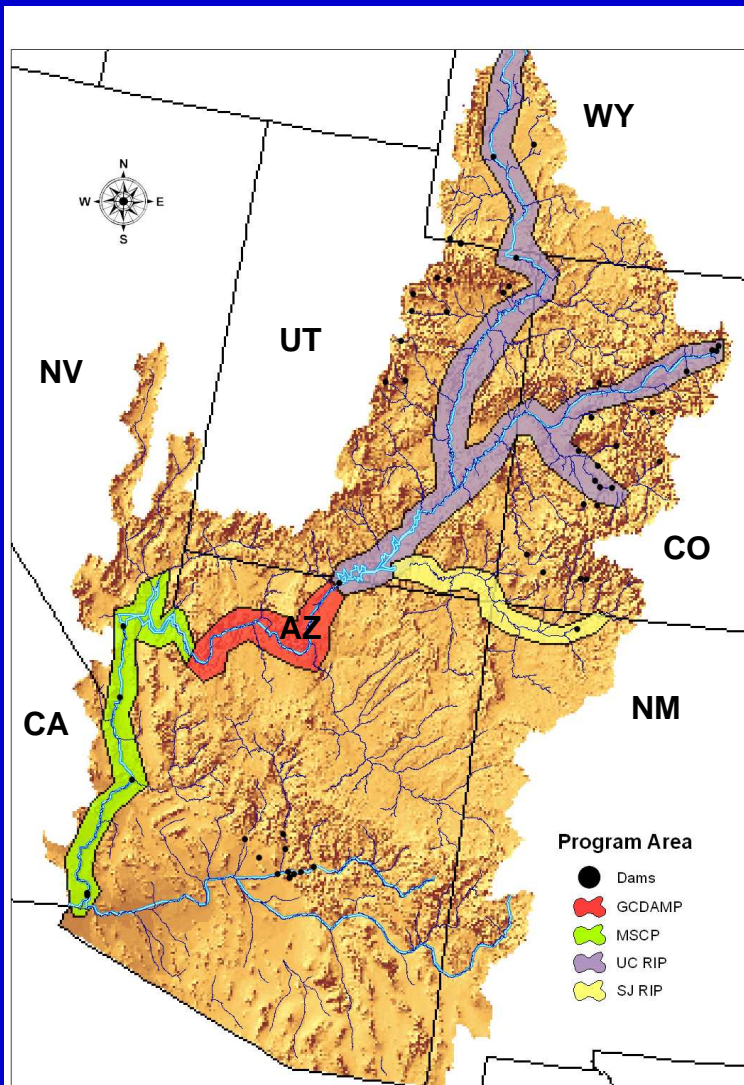


In the view of conservationists, there is something special about dams, something—as conservation problems go—that is disproportionately and metaphysically sinister...The conservation movement is a mystical and religious force, and possibly the reaction to dams is so violent because rivers are the ultimate metaphors of existence, and dams destroy rivers.



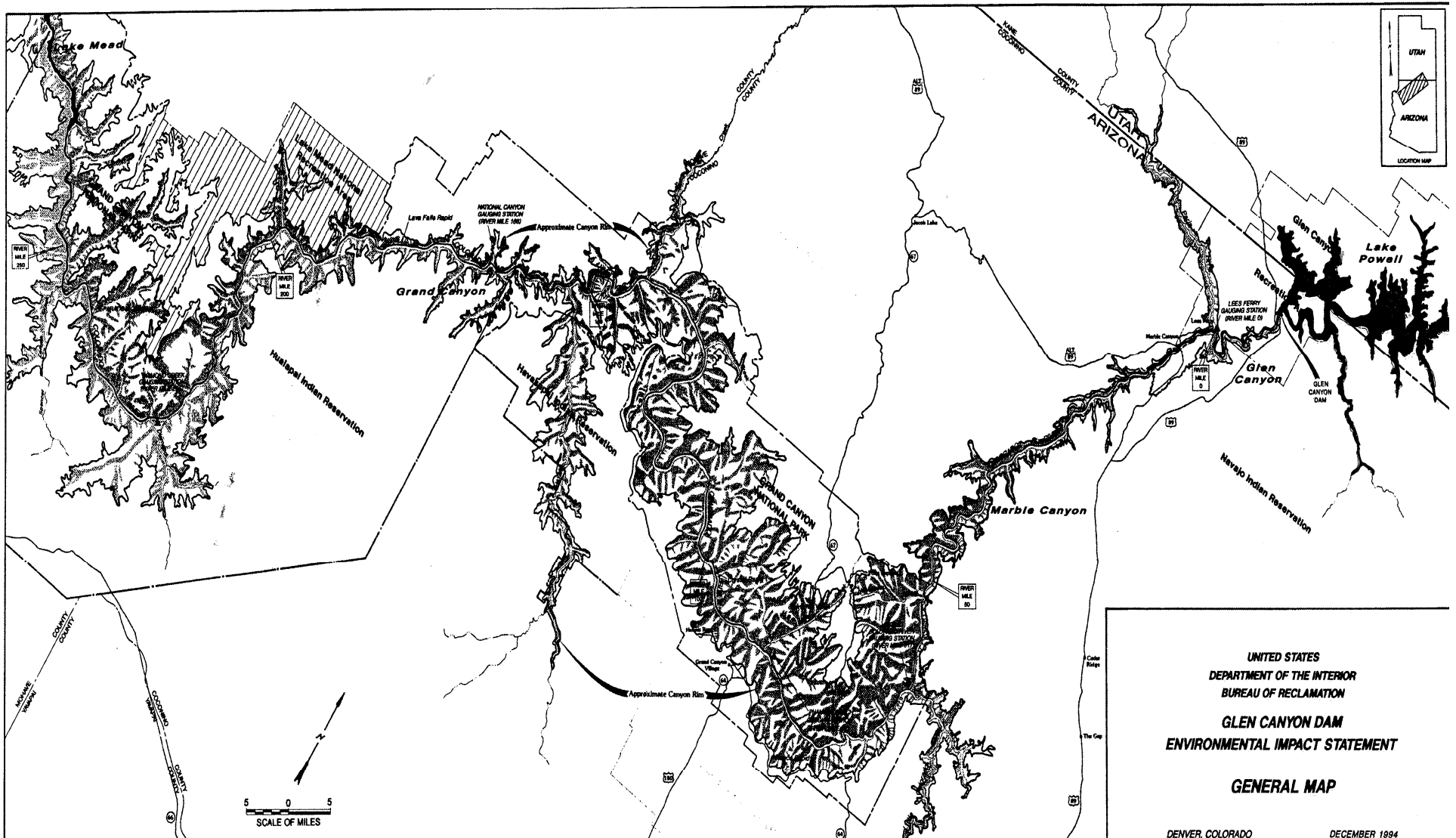
John McPhee

Federal-State-Tribe-Stakeholder Cooperation in the Colorado River Basin

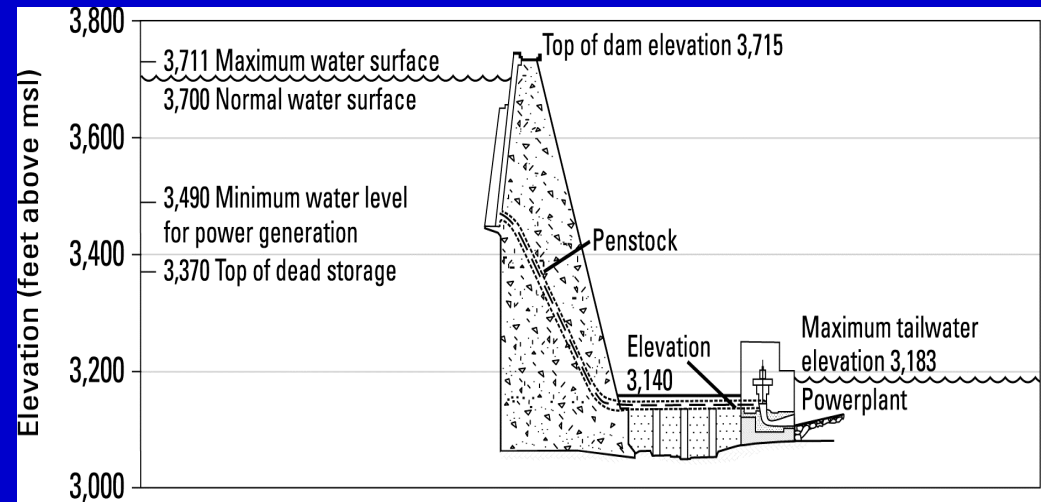


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Colorado River Glen and Grand Canyons



Glen Canyon Dam and Powerplant



- Located Page, Arizona
- Authorized by CRSP Act 1956
- Began Operation 1963
- Concrete Arch Dam
- 710 feet high
- 26.5 MAF Storage
- Eight Francis turbines
- 1,320 MW capacity



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Legal/Policy Background

- **1963 Glen Canyon Dam completed**
- **1970s Initial concern over dam effects**
- **1982 Reclamation agrees to evaluate effects**
- **1989 EIS initiated on operation of GCD**
- **1992 Grand Canyon Protection Act**
- **1994 FWS Biological Opinion**
- **1995 EIS completed**
- **1996 ROD signed**
- **1997 AMWG FACA charter/AM officially begins**

GCPA of 1992

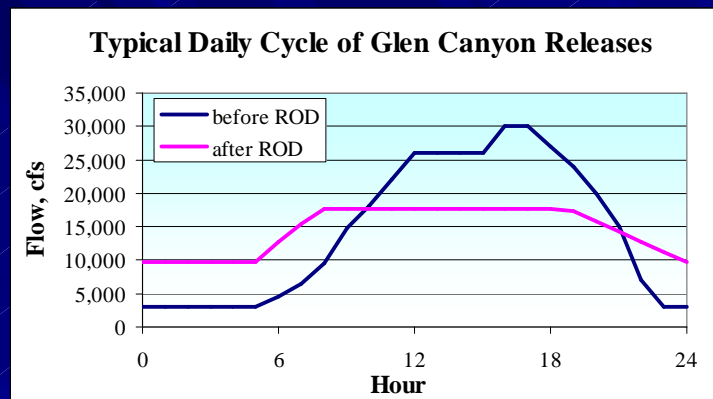
- Added to environmental commitments included in NHPA, NEPA, CWA, and ESA
- Secretary shall operate Glen Canyon Dam...and exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use.
- Secretary will achieve the above in compliance with existing laws governing allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

Resource Conflicts Below Glen Canyon Dam

1952



Whitewater River Running



Hydropower Production

1995



Fine Sediment and Beaches



Cultural Resources



Sportfish and Endangered Fish



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Expected Outcome of 1996 ROD

- No change to Compact water deliveries
- Minimum reduction of power benefits to achieve ecosystem goals
- Benefit native and endangered species
- Positive sand storage and improved physical habitat
- Protection of tribal cultural resources
- Improve aquatic and terrestrial resources
- Recreation – increased safety and improved experience



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Did everyone agree? No

- 9 alternatives considered in the EIS
- Ranged from maximizing hydropower to seasonally adjusted steady flows
- FWS issued jeopardy Biological Opinion
- Stalemate and deadlock
- Compromise: adaptive management

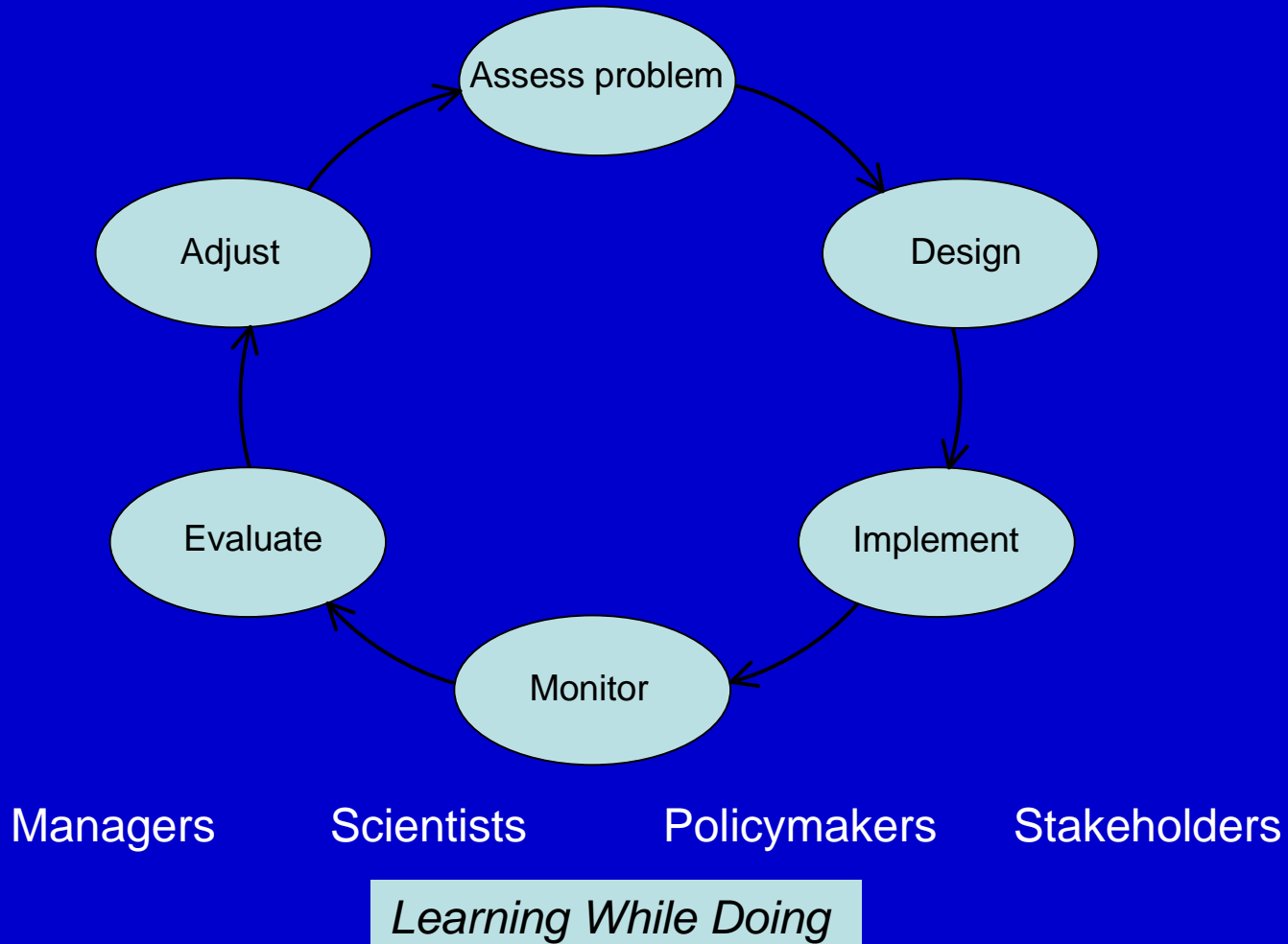
Decision Making Approaches

- political/social approach
- conventional-wisdom approach
- best-current-data approach
- monitor-and-modify approach
- adaptive management approach

Increasing Complexity
Increasing Resources, Time and Money
Broader, More Diverse Involvement



Adaptive Management Process



Structure of the GCDAMP

Secretary of
the Interior

Designee

Adaptive Management
Work Group

❑ 7 Colorado River Basin
States (WY, CO, UT, NM,
AZ, NV, CA) and AZ Game
and Fish

❑ 2 Power user groups
(CREDA and UAMPS)

❑ 2 Recreation groups
(Grand Canyon River
Guides and Federation of
Flyfishers)

❑ 5 DOI agencies (USBR,
USGS, FWS, NPS, BIA) and
DOE (WAPA)

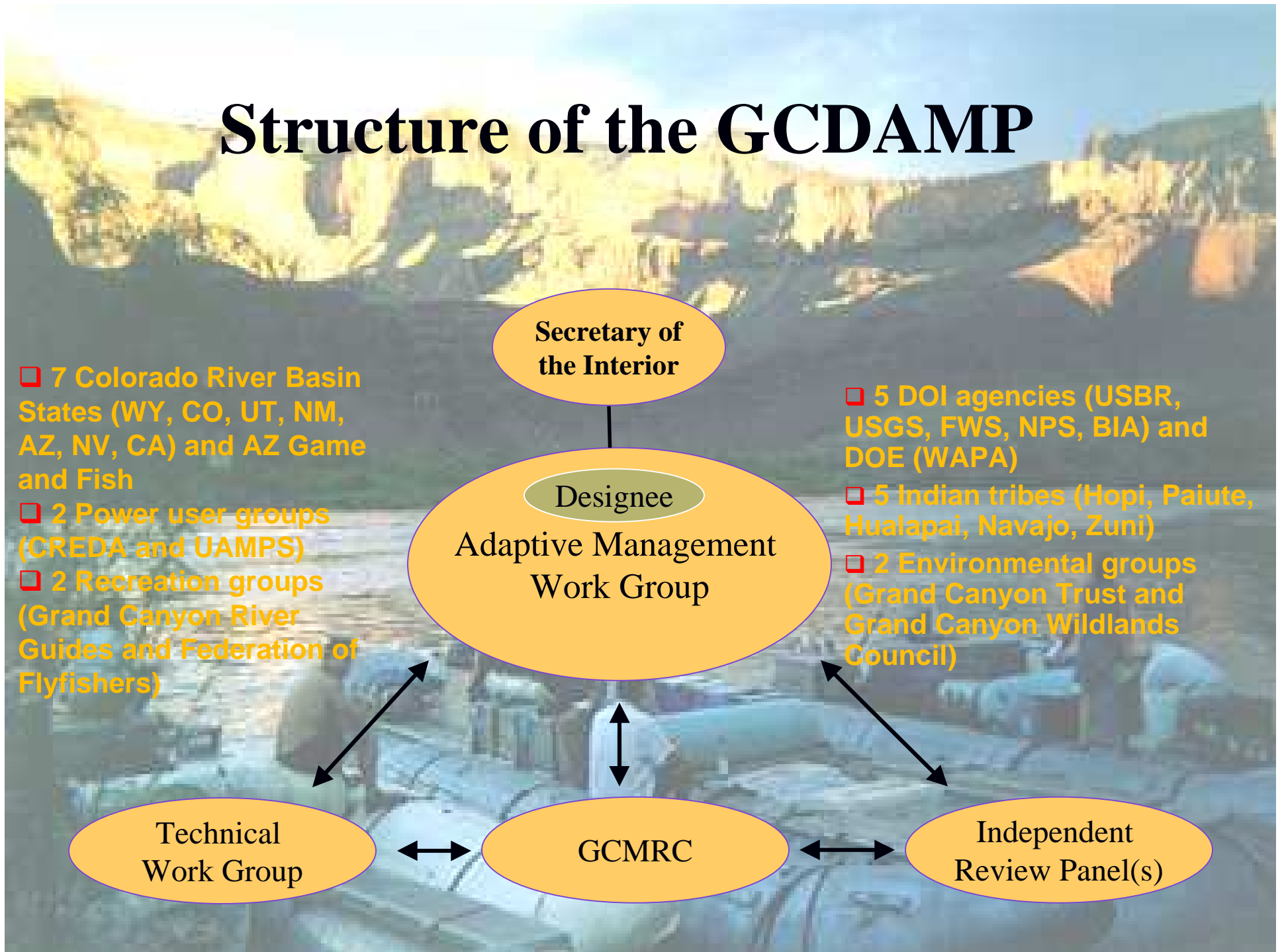
❑ 5 Indian tribes (Hopi, Paiute,
Hualapai, Navajo, Zuni)

❑ 2 Environmental groups
(Grand Canyon Trust and
Grand Canyon Wildlands
Council)

Technical
Work Group

GCMRC

Independent
Review Panel(s)



How the GCDAMP Functions

- The Adaptive Management Program focus is on the Colorado River ecosystem;
- Models are developed to reveal the potential effects of policies, activities, or practices that are being considered for implementation;
- Questions are formulated as testable hypotheses regarding the expected responses or linkages of the Colorado River ecosystem to dam operations and other management actions;
- Experiments are conducted to test hypotheses and answer questions;
- Management activities reveal, through monitoring and evaluation of results, the accuracy or completeness of the earlier predictions; and
- New knowledge and information produced through experimentation are incorporated into management discussions and recommendations to the Secretary of the Interior.

GCDAMP Development

- Vision and Mission Statement
- 9 Principles
- 12 Goals
- 52 Management Objectives
- Research and Monitoring Information Needs to Address Management Objectives
- Annual Budgets and Workplans

GCDAMP Goals

1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.
2. Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitat.
4. Maintain a naturally reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.
9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of the Adaptive Management Program ecosystem goals.
10. Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of the Adaptive Management Program ecosystem goals.
11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present, and future generations.
12. Maintain a high quality monitoring, research and adaptive management program.

So,
how well is it working?

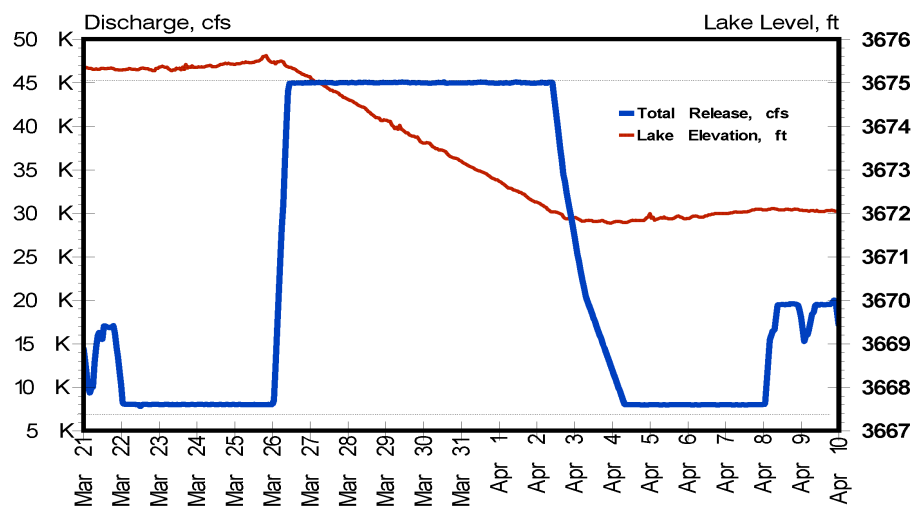
- Knowledge improvement
- Resource status
- Stakeholder cooperation
- Legal implementation

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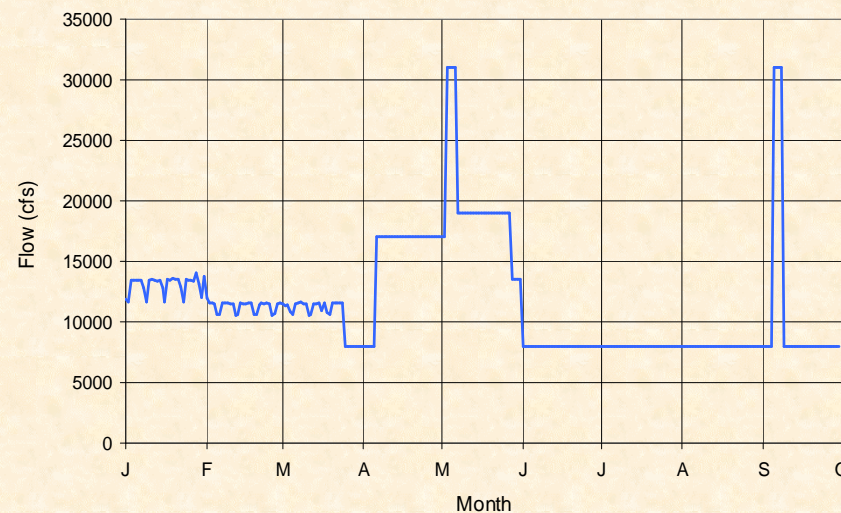
Knowledge improvement

- Science institution in USGS
- Competitive awarding of contracts (peer review)
- Development of conceptual models
- Careful consideration of Adaptive Management program protocols
 - How should managers and scientists interact?
 - How should recommendations or decisions be made?
 - External protocol evaluation panels
 - Oversight from Science Advisors

Discharge and Surface Elevation of Lake Powell during the Controlled Flood Release, March 21 to April 10, 1996

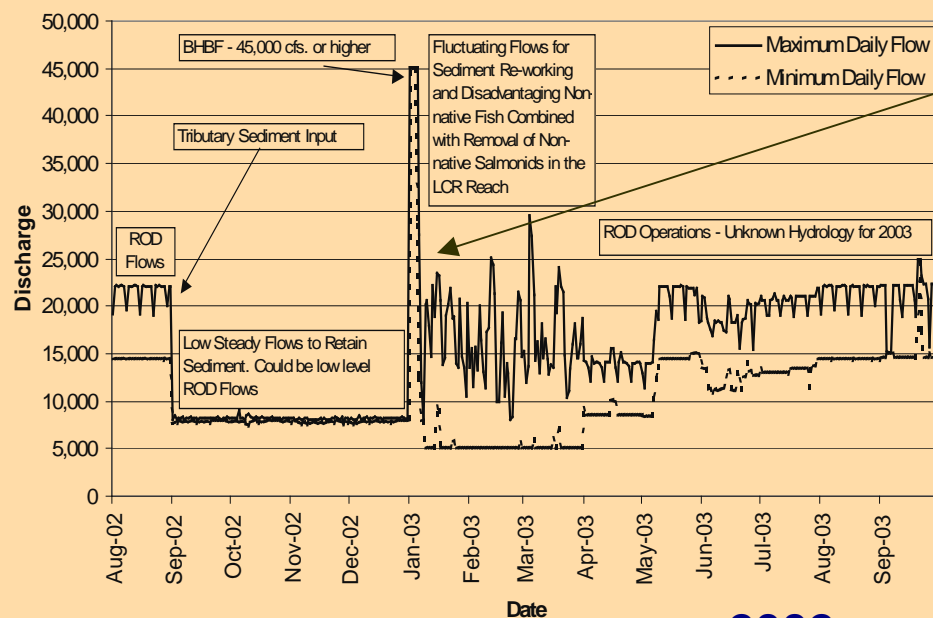


2000



Experimental Hydrographs

Scenario 1. GCMRC Recommended Water Year 2002-03 Treatment

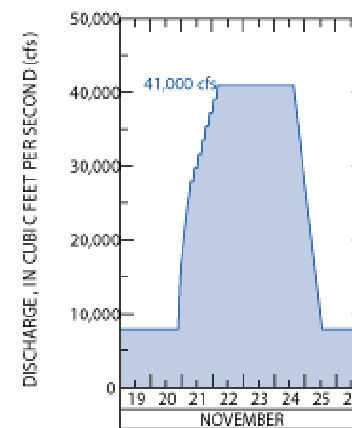


2002

Required Sediment Triggers

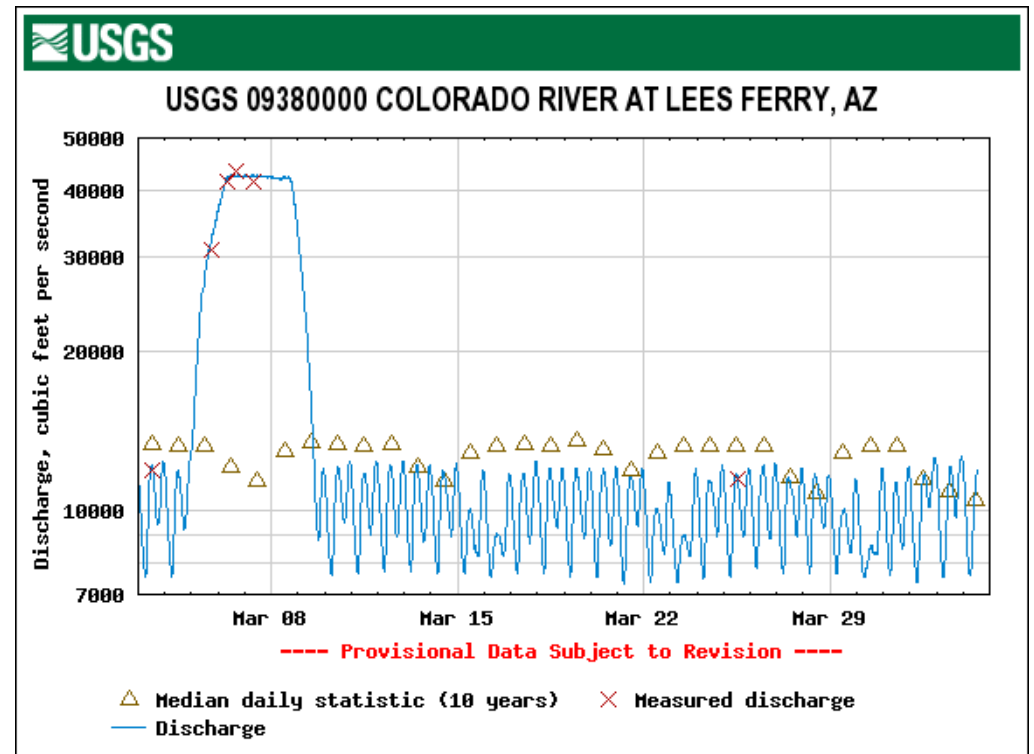
2004

Hydrograph of the planned high release from Glen Canyon Dam, 2004

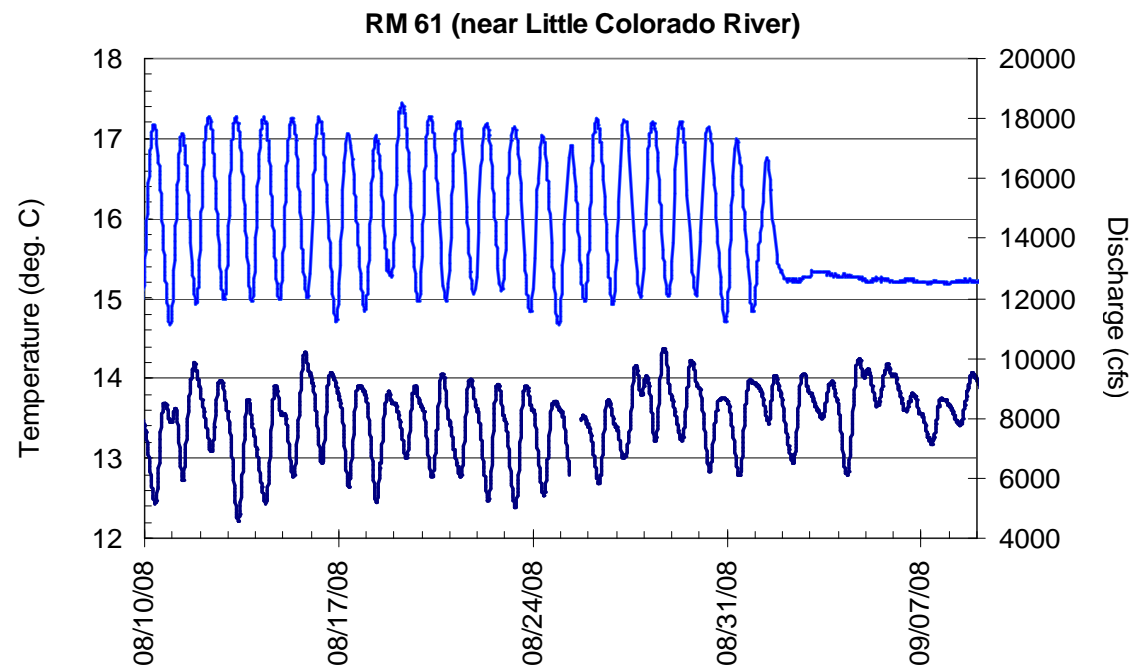


2008 Experimental Flows

March High Flow



September-October Steady Flows



2005 Knowledge Assessment

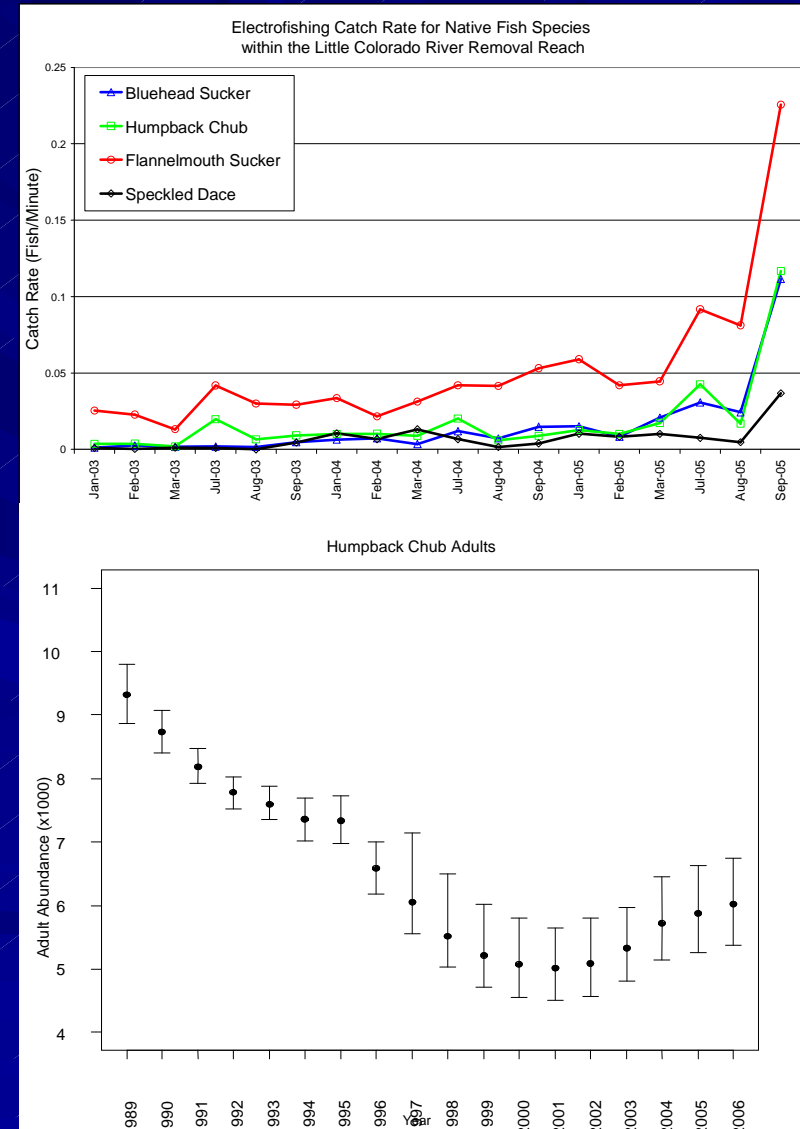
	Very Certain	Certain	Uncertain	Very Uncertain
Prediction	Direction and magnitude of response	Direction only	Direction only	Cannot predict direction
Supported by Data from Colorado River Ecosystem	Peer-reviewed, likely involving a model. Little debate on interpretation of predictions	Peer-reviewed results, no model	Limited data without peer-review and likely debatable inference	No or very limited data
Data from Other Reference Systems	Validated prediction in other system that is considered a good model for CRE	Validated prediction in other system that is a weaker model for CRE	Weaker prediction from other system that is a weak model for CRE	No or very limited data in other systems. Other systems are not good model of CRE
General Theory / Conventional Wisdom	Very Strong	Good	Moderate	Low
Probability that Predicted Direction is Correct	90-100%	70-90%	50-70%	<50%

Table 3.3. Knowledge assessment matrix for food base and fish sub-models.

Performance Measure	Location and/or Species	Increase in GCD Release Water Temp.	Overall Effect of Increased Fluctuations Relative to MLFFA	Reduce Variation in Monthly Volume	BHBF with adequate sand supply	BHBF without adequate sand supply	HMF with adequate sand supply	HMF without adequate sand supply	Sustained Low Steady Flow (summer-fall)	High Sustained Flow (ponding-spring)	Mechanical Removal of Coldwater Exotics (Mainstem and Trib)	Mechanical Removal of Warmwater Exotics
Food base	Glen	+		+					-	+		
	Grand	+	-						-	+	+	
Mainstem spawning & incubation	HBC	+							+		+	+
	FMS	+	-						+		+	+
	RBT-Glen		-	+					+	+		
	RBT-Marble											
YOY/Juvenile near shore rearing	HBC	+	-	+		-		-	+		+	+
	FMS	+	-	+		-		-	+		+	+
	RBT-Glen	+	-	+	-	-	-	-	+	+		
	RBT-Marble		-	+	-	-	-	-	+	+		

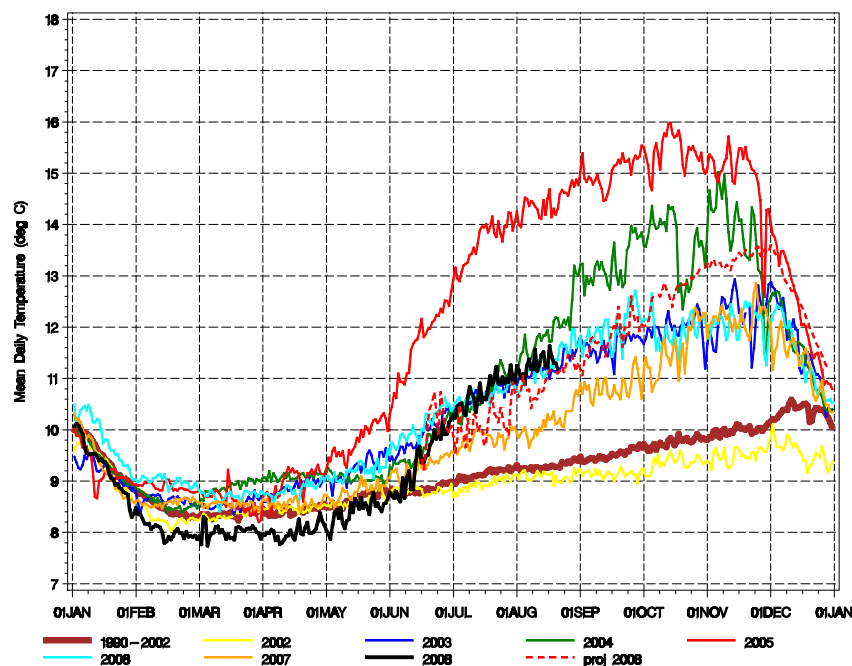
Status of Selected Resources

- Water compact requirements continue to be met
- Greater aquatic productivity in the tailwater
- Decreased tailwater rainbow trout, but with higher condition factor
- Declining population of endangered humpback chub stabilized and increasing
- Always rare endangered razorback sucker may be extirpated
- Other native fish species exhibiting population increases
- Mechanical removal of non-native fish has markedly reduced their populations



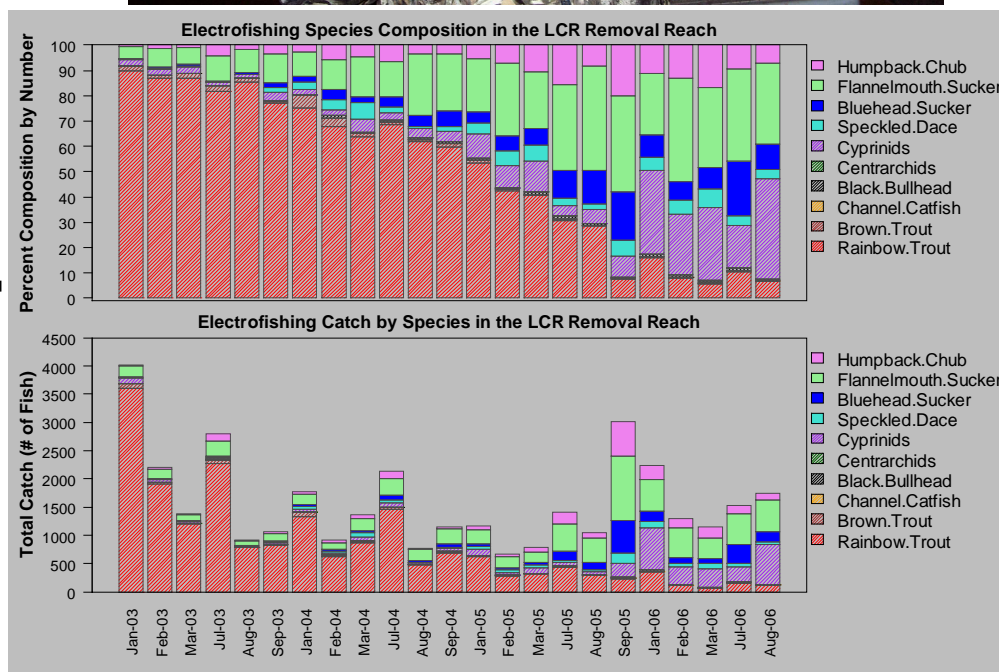
Status of Selected Resources

Potential Causes of Native Fish Increases



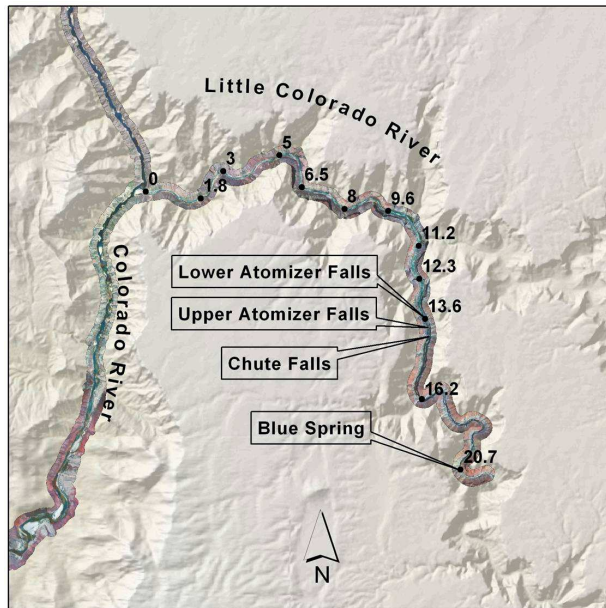
Warmer Dam Releases...and/or...

**Mechanical Removal
of Non-native Fish...and/or...**



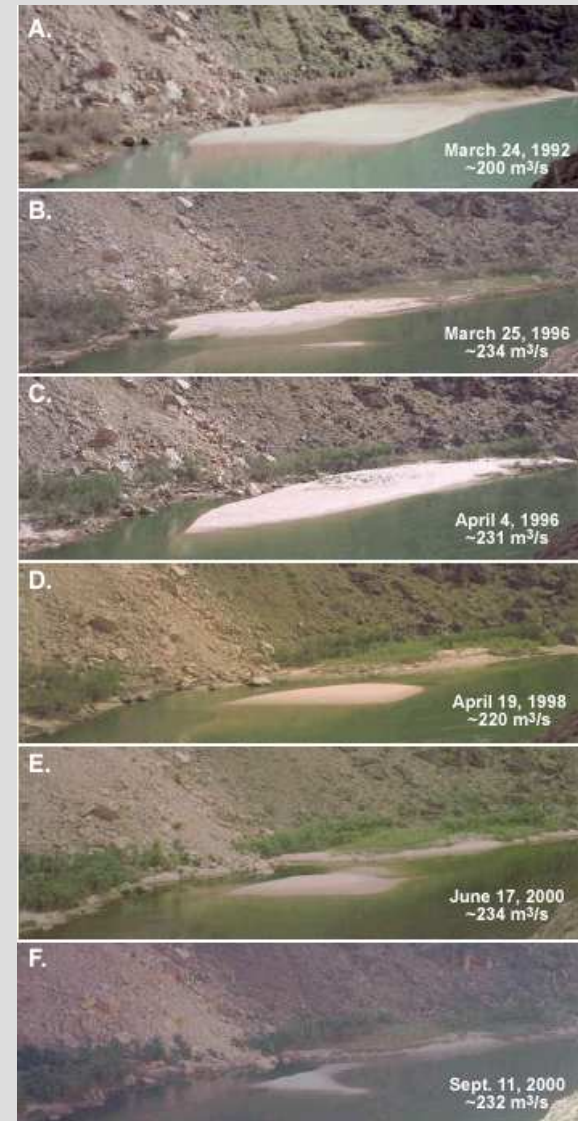
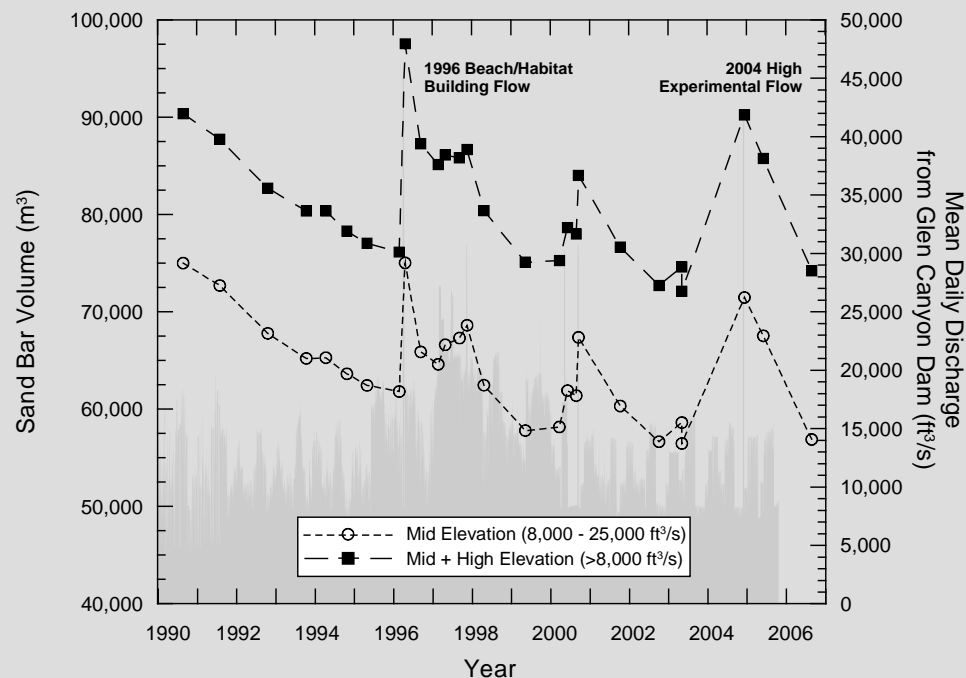
Tributary Translocation

- Conservation Measure of 2002 & 2008 BO
- Translocated 1,466 juvenile humpback chub 50-120 mm TL
- Marked with elastomer or PIT tags
- Reduced mortality of young chubs
- Increased abundance of HBC
- Better understanding of life history



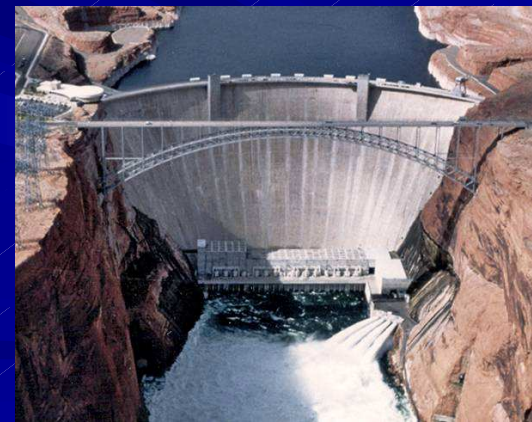
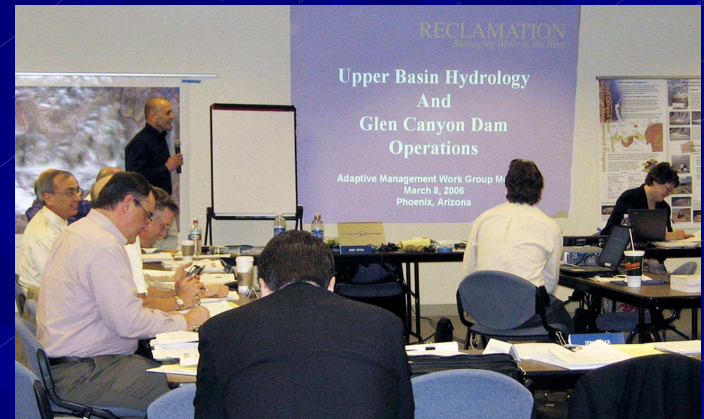
Status of Selected Resources

- Sediment-triggered floods temporarily improve beach building and improve sediment retention
- Further curtailment of load-following hydropower production; experiments have resulted in costs to power customers



Stakeholder Cooperation

- Developed vision, mission, goals, management objectives, and strategic plan
- Disparate interests and values remain, but willing to engage, discuss and plan
- Major experiments agreed to and recommended to Secretary of the Interior
- Willingness to look beyond dam operations for resource protection
- Development of comprehensive plan for humpback chub recovery actions



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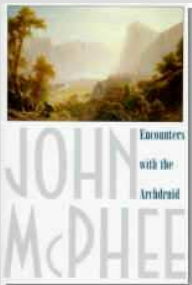
Legal Implementation

- Limits of experimentation tied to 1996 Record of Decision
- Experiments conducted with tribal government-to-government consultation and with NHPA, NEPA and ESA compliance
- Ongoing litigation will further define sufficiency of compliance

Looking to the future

- New compliance on a 5-year plan of experimental actions 2008-2012
- Increased emphasis on modeling to supplement large-scale field experiments
- Investigate feasibility of sediment augmentation
- Integrate dam operations and other management actions, e.g. non-native species control, translocations of endangered species
- Managers desire to transition from research to management actions

“I will come out of this trip different than when I went in. I am not in favor of dams, but I am in favor of Dominy. I can see what you have meant to the Bureau, and I am worried about what is going to happen there someday without you.”



“I love to see white water, Dave. In all my trips over the years, I have found moving streams with steep drops to them the most scenic things of all...As a matter of fact Dave Brower, I’ll make a trip with you anytime, anywhere.”



